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GB A 2039215 GB 1460101
GB 1487187 GB 1339445

(58) Field of search
B5A

(54) Injection moulding

(57) A process of producing an injection moulding comprises introducing molten plastics material in the form of a stream into a mould space, and at one or more selected positions injecting a predetermined, finite quantity of fluid under pressure into the stream of plastics material at a controlled rate, the fluid flowing with the plastics material between the mould surfaces to fill the mould space and exerting an outward pressure on the surrounding plastics material to pressurise the plastics material towards the mould surfaces.

The fluid may be a gas such as nitrogen which forms a pressurised mass in the plastics material, the pressure being relieved before the mould is opened thereby forming an article having an internal cavity. Alternatively, the fluid may be a liquid blowing agent or a mixture of a gas and a liquid blowing agent which results in an article having a porous core surrounded by an outer plastics skin.

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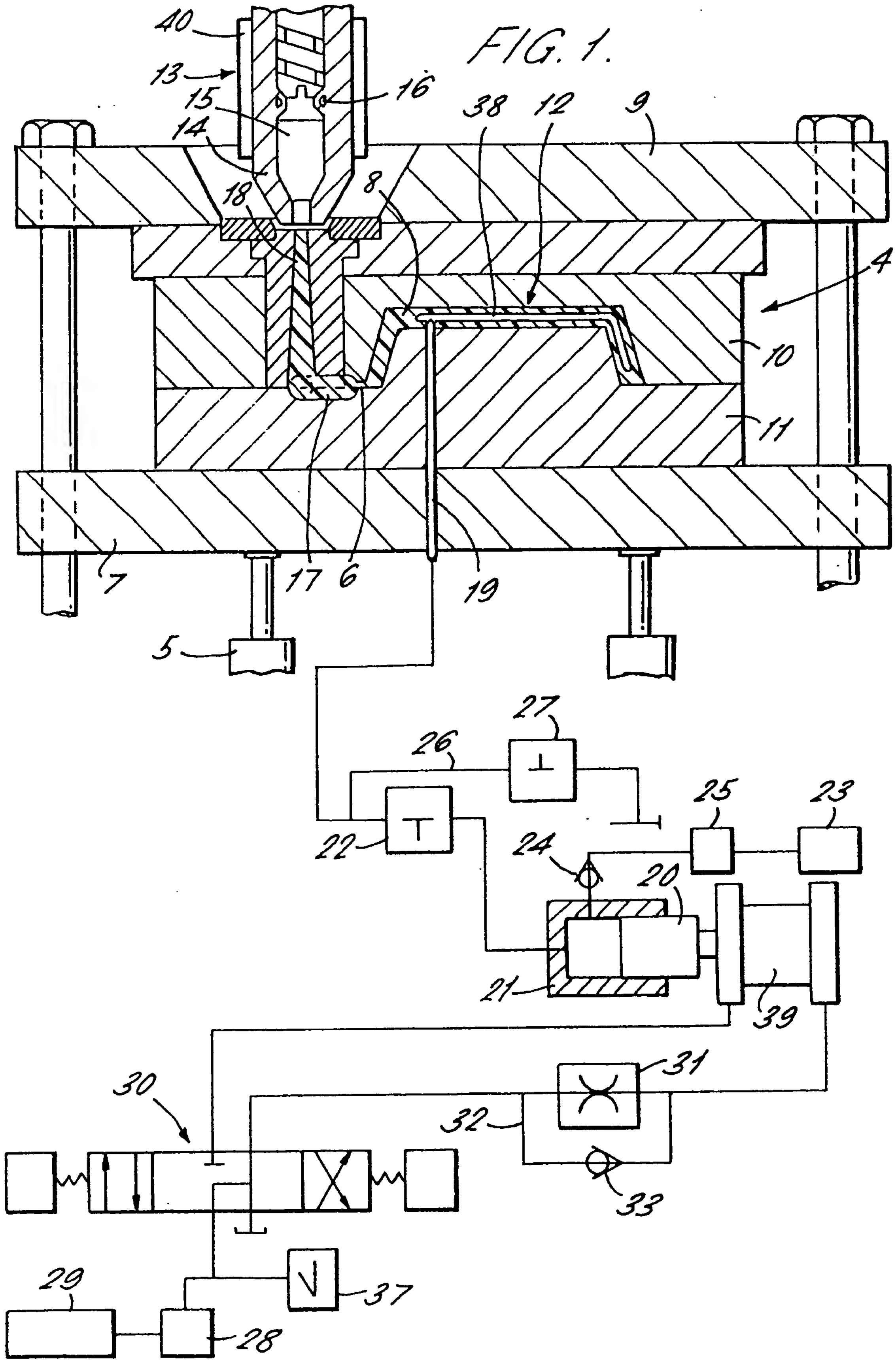
FIG. 1.



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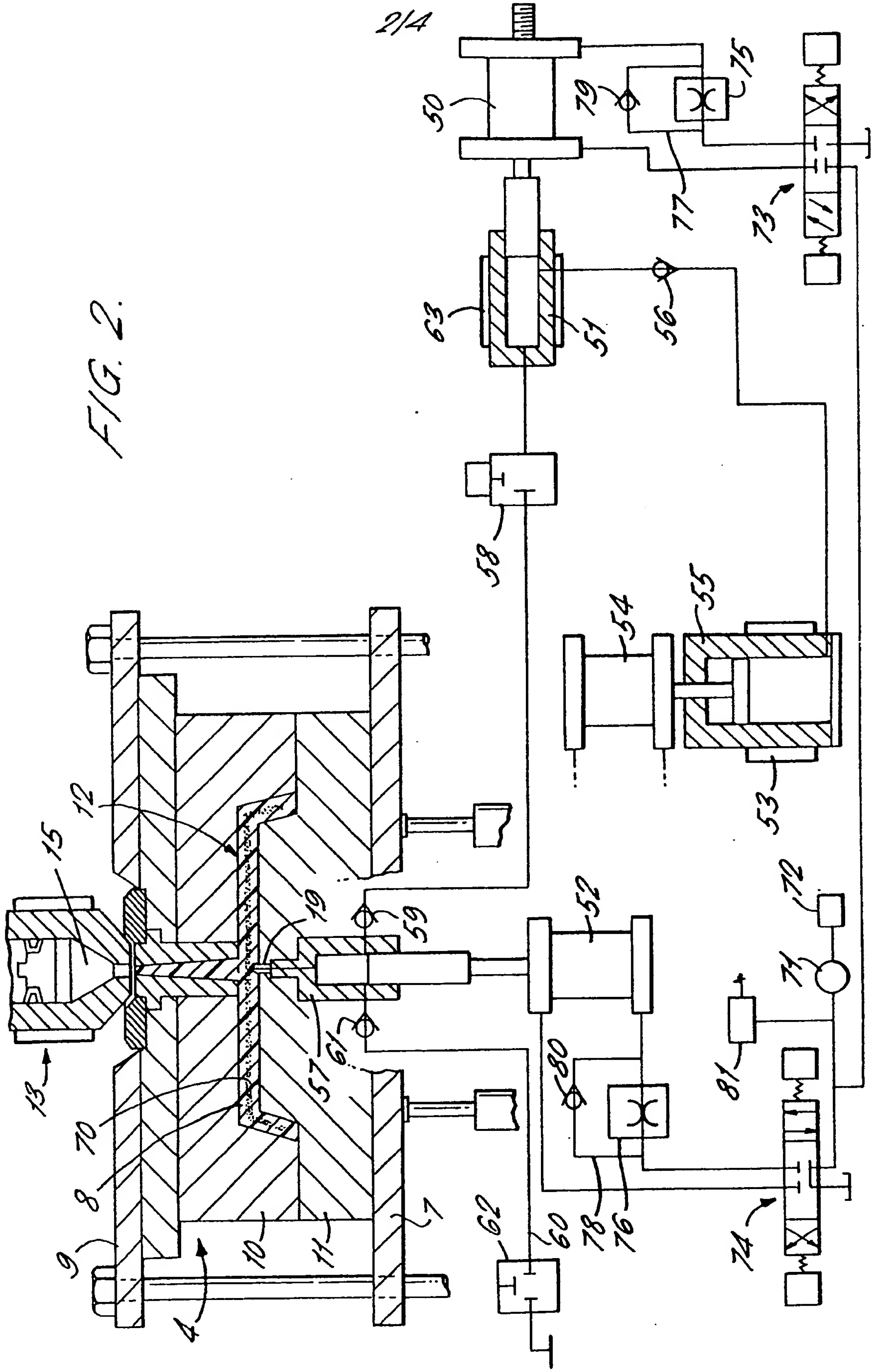

FIG. 2.

FIG. 3.

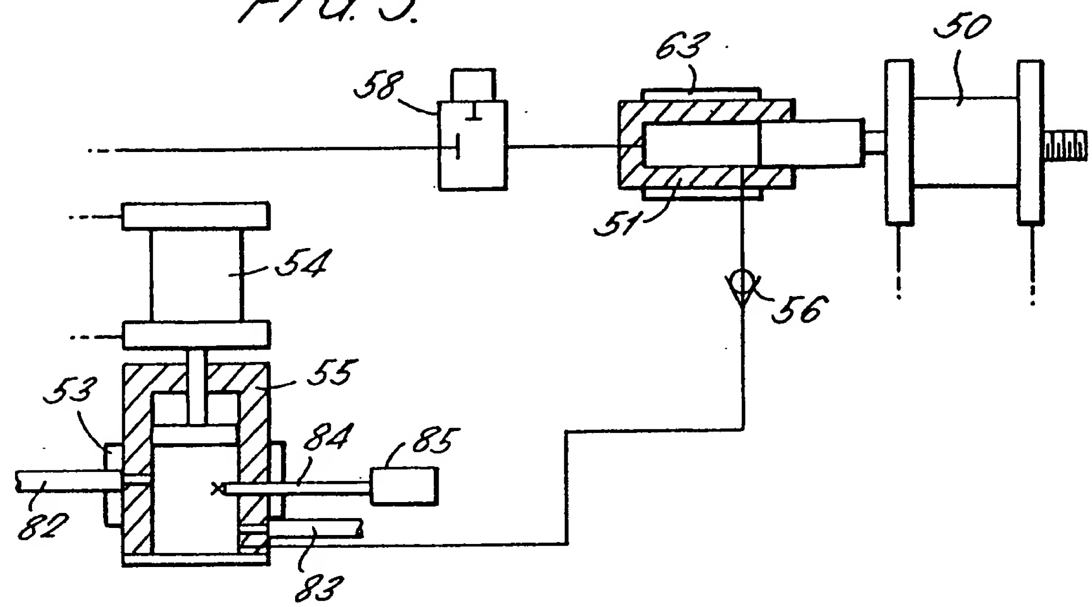
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FIG. 4.

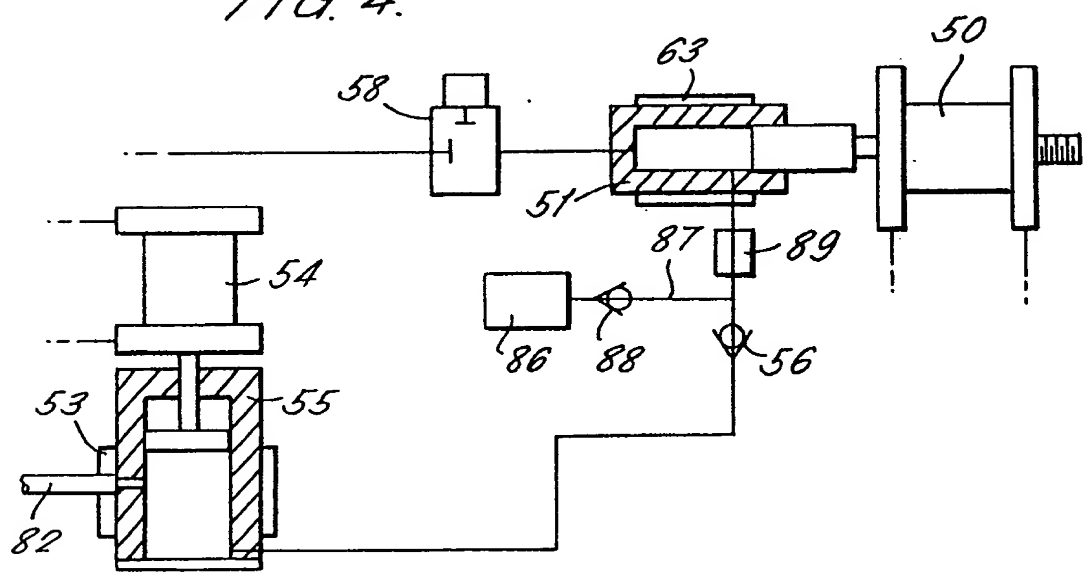
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FIG. 5.

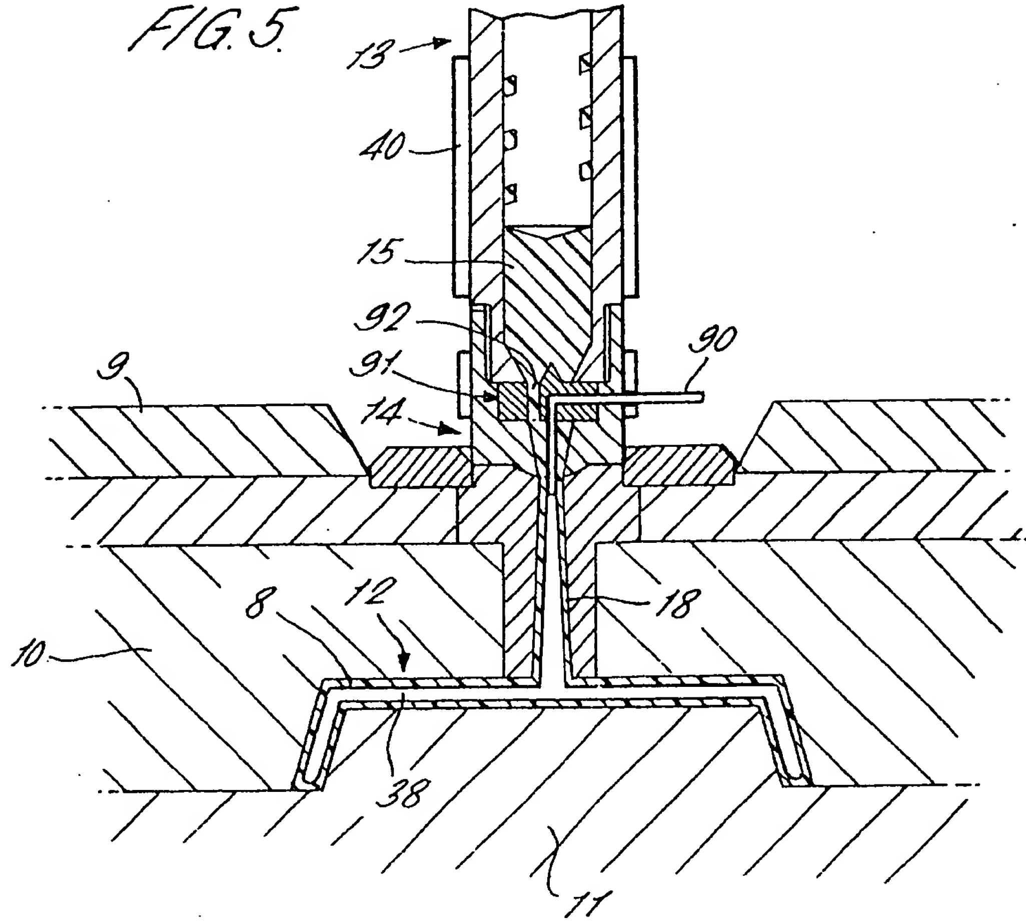
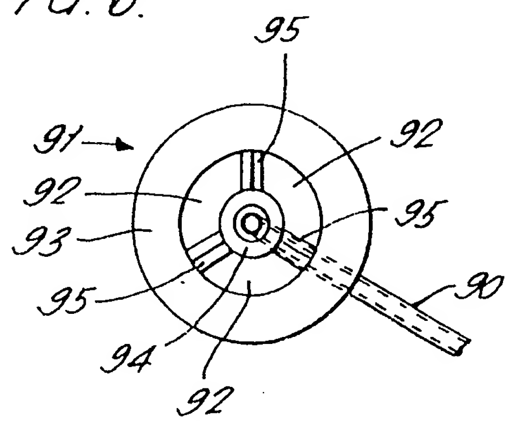


FIG. 6.



SPECIFICATION

Injection Moulding and Mouldings Produced Thereby

This invention relates to a process and apparatus for injection moulding and mouldings produced thereby. More particularly, the invention relates to the injection of a fluid under pressure into a stream of plastics material simultaneously to the introduction of the plastics material into a mould space. This fluid creates a pressurised mass of fluid or a porous core within the plastics material for the dual purpose of reducing the weight of the resultant moulding (and also the quantity of plastics material) and the application of an outward pressure on the plastics material urging it towards the mould surfaces until such time that the surrounding wall of plastics material is self-supporting. This outward pressure assists the mould space to be filled and to give the moulding an improved surface finish.

According to the invention there is provided a process of producing an injection moulding comprising introducing molten plastics material in the form of a stream into a mould space, and at one or more selected positions injecting a predetermined, finite quantity of fluid under pressure into the stream of plastics material at a controlled rate, the fluid flowing with the plastics material between the mould surfaces to fill the mould space and exerting an outward pressure on the surrounding plastics material to pressurise the plastics material toward the mould surfaces. The plastics material may include a blowing agent premixed therein.

Preferably the process includes the step of measuring the predetermined quantity of fluid in a chamber prior to the injection of the fluid into the plastics material.

It is also preferred that the pressure of the fluid injected fluctuates with the pressure, of the plastics material, whilst remaining higher than that pressure to ensure a uniform injection of the fluid throughout the moulding cycle.

Some or all of the fluid may be injected into the plastics material at one or more selected positions within the mould space, or alternatively upstream of the mould space.

In one embodiment of the invention it is preferred that the fluid is a gas, which may be air but is preferably nitrogen or other inert gas. Alternatively, the fluid may be a liquid, but again it is preferable that the liquid is inert relative to the plastics material being moulded and not e.g. water which would require additional apparatus to control the effect of the steam produced on contact of the water with the hot plastics material. If desired the fluid may be a mixture of a liquid and a gas.

In this embodiment, during the flow of the fluid with the plastics material, the fluid preferably forms at least one mass within the plastics material which exerts said pressure on their plastics material towards the mould surfaces, and the process includes the steps of maintaining the pressure until the plastics material is self-supporting and then relieving the pressure or allowing the pressure to dissipate itself to an acceptable level before the mould is opened. Also, in a case in which at any one selected position the fluid injected is a gas, the volume of the respective mass may be formed by a portion only of the finite quantity of gas, the remainder of the gas being injected into the mass to increase the pressure therein, whereby a correspondingly increased outward pressure is applied to the plastics material. If desired more than one mass of the fluid within the plastics material is formed by discontinuous injection of the fluid at the selected position or one of said positions, the pressure from each mass being relieved separately. In either case, the pressure in the or each mass may be relieved by causing fluid to leave the mass.

In another embodiment the fluid is a liquid blowing agent or a mixture of gas and a liquid blowing agent which is injected into the plastics material at a temperature which is below its decomposition temperature, the fluid being heated to its decomposition temperature by the plastics material whereby the fluid creates a porous core which exerts said pressure on the surrounding plastics material, any undesired excess pressure or residue of the fluid being removed or allowed to dissipate itself before the mould is opened. It is preferred but not necessarily essential that the blowing agent is preheated before it is injected into the plastics material.

The invention also provides an apparatus for producing an injection moulding comprising means for introducing molten plastics material into a mould space, separate means for injecting fluid under pressure into the stream of plastics material at one or more selected positions, means for measuring a predetermined, finite quantity of the fluid to be injected, and means for controlling the rate of injection of the fluid.

Preferably for the or each selected position the fluid injection means is a piston and cylinder arrangement, the cylinder being connected by a passageway projecting into the path of the plastics material. The cylinder of the fluid injection means may be a measuring chamber for the fluid. Alternatively, for the or each selected position the fluid injection means may include a second piston and cylinder arrangement connected in series and upstream of the first-mentioned piston and cylinder arrangement, the cylinder of the second piston and cylinder arrangement comprising a measuring chamber for the fluid.

Preferably the effective volume of said measuring means is adjustable to allow the finite quantity of the fluid to be varied.

The invention further provides an injection moulding of plastics material having a porous core surrounding by a wall or skin of plastics material, the porous core being formed during the formation of the moulding. Preferably the

injection moulding is formed by a process or apparatus as defined above.

By way of example, specific embodiments in accordance with the invention will be described with reference to the accompanying diagrammatic drawings in which:—

Figure 1 is a layout of a mould and a screw ram of an injection moulding press;

Figure 2 is a layout of a mould and a screw ram of another injection moulding press;

Figures 3 and 4 show alternative modifications of the injection moulding press of Figure 2;

Figure 5 shows a different arrangement in which the fluid is injected at a position upstream of the mould space; and

Figure 6 is an end view of part of the nozzle and the fluid injection passageway of the arrangement of Figure 3.

Regarding Figure 1, a mould 4 for use in an injection moulding press has upper and lower mould parts 10, 11 defining a mould space 12. The mould parts 10, 11 are mounted between a fixed platen 9 and a platen 7 movable by a hydraulic ram 5. Molten thermoplastics material 8 is introduced into the mould space 12 by a screw ram 13 having a nozzle 14, feed chamber 15, check ring 16, and heater 40 in known manner. The plastics material enters the mould space 12 from the nozzle 14 through a sprue 18, a runner 17 and a gate 6.

During the moulding process it is desired to create a pressure within the plastics material 8 to urge the surrounding plastics material outwardly into contact with the mould surfaces and thereby assist the external surface of the plastics material to take up the precise nature of the mould surfaces. The pressure also assists the mould space to be filled, especially in the case of narrow or extended positions which are normally difficult to fill. This pressure is applied by a fluid injected at at least one selected position, under pressure, into the plastics material as it flows between the moulding surfaces.

For this purpose a fluid injection passageway 19 extends, in this embodiment, through the lower mould part 11 into the mould space and protrudes upwardly within the mould space to a point between, preferably substantially mid-way between, the upper and lower surfaces.

In this embodiment the fluid is a gas but it could be a liquid. The gas will be described as nitrogen which is the preferred gas since it is inert and reasonably cheap. To transmit the nitrogen to the passageway 19 there is provided a hydraulic ram 39 having a piston 20 and cylinder 21 connected to the passageway 19 via a solenoid operated valve 22, and to a nitrogen supply 23 via a non-return valve 24 (or a solenoid operated valve) and a pressure regulator 25. Downstream of the valve 22 the passageway 19 has a return connection 26 via another solenoid operated valve 27 either to waste or back to the nitrogen supply 23 so that at least some of the nitrogen is recirculated. The cylinder 21 constitutes a chamber for measuring the predetermined, finite quantity of nitrogen it is desired to inject into the plastics material through the passageway 19 in any particular moulding cycle, both to create the required internal pressure and reduction in weight of the resultant product. The stroke of the piston 20 is adjustable so that the effective volume of the cylinder 21 and thereby the quantity of nitrogen to be injected may be varied. The control means of the ram 39 includes a hydraulic pump 28 operated by an electric motor 29 and protected by a pressure relief valve 37, a two-directional solenoid operated valve 30, and a flow control valve 31 having a bypass 32 including a non-return valve 33.

In operation the injection chamber 15 of the screw ram 13 is filled with sufficient molten plastics material to form the product to be moulded. The mould parts 10, 11 are closed and the moulding pressure applied by the platens 7 and 9 and the ram 5. The stroke of the piston 20 of the hydraulic ram 39 has been pre-set and is in its rear resting position, so that the cylinder 21 is filled with a predetermined quantity of nitrogen from the supply 23. This quantity is either the minimum amount which is required to reduce the weight of the moulding to the desired level or a predetermined greater amount for the reason explained below. The pressure of the nitrogen in the cylinder 23 is at the pressure set by the pressure regulator 25.

A pressure switch (not shown) is tripped indicating that the full clamping tonnage required is applied to the mould parts 10, 11. The plastics material in the injection chamber 15 is then introduced into the mould space 12 through the sprue 18, runner 17 and gate 6 by the screw ram 13. As soon as the plastics material 8 within the mould has passed and immersed the outlet end of the passageway 19, solenoid valve 22 is opened (valve 27 being closed), and the directional valve 30 operated to allow the ram 39 to inject the nitrogen in the cylinder 21 through the passageway 19 into the plastics material at a rate controlled by the flow control valve 31. The nitrogen is thereby injected approximately into the middle of the thickness of the plastics material and forms a channel or channels or other mass 38, as desired, therein. The end of the stroke of piston 20 of the ram 39 may be timed to substantially coincide with the completion of the filling of the mould space 12 with plastics material 8, i.e the end of the stroke of the screw ram 13. Alternatively, when the screw ram 13 has travelled its full stroke, the piston 20 may have some forward movement remaining, which is completed after the end of the introduction of plastics material. The result is that the nitrogen continues to be injected into the mass 38 formed within the plastics material after the mould space is full, whereby the pressure of the nitrogen in the mass 38 is increased and thereby the outward pressure applied on the plastics material urging it towards the mould surfaces to improve the plastics surface definition.

Both rams 13, 39 remain in their full operative

positions until the moulded part and the sprue have cooled and their surface skin is self supporting. Ram 13 may then be withdrawn. Also the directional valve 30 is reversed to allow the ram 39 to return to its rest position, the oil from the ram 39 returning to tank through the non-return valve 33 and the piston 20 being moved by the pressure of the nitrogen in the passageway 19. On completion of the return movement of the piston 20, valve 22 is closed. The pressure of the nitrogen trapped in the cylinder 21, and also the pressure of the gas still downstream of the valve 22, both in the passageway 19 and the mass 38, has thereby halved compared with the previous pressure, i.e. if the pressure was 400 p.s.i. it is now 200 p.s.i.. Valve 27 is then opened which relieves the remaining pressure of the nitrogen in the moulded part to the desired level which may be atmospheric pressure or above. The nitrogen emitted passes to atmosphere or at least some of it is returned to the supply 23 for recirculation during a subsequent moulding cycle. The feed chamber 15 of the screw ram 13 and the cylinder 21 of the ram 39 may also be refilled with plastics material and nitrogen respectively in readiness for the next operating cycle. Finally the clamping pressure on the mould is relieved and the mould opened to remove the moulding.

The recirculation of some or all of the nitrogen extracted from the moulding during each operating cycle may be an advantage since the nitrogen returned will retain some of the heat from the previous cycle and thus result in the nitrogen injected during the next cycle having a temperature nearer that of the incoming plastics material than would otherwise be the case.

It will be appreciated that the embodiment described above allows an exact amount of nitrogen or other gas to be metered and injected into the plastics material. Also the pressure of the nitrogen injected is dictated by the injection pressure of the plastics material. In each moulding cycle the plastics injection pressure may vary. However, the pressure on the nitrogen injection ram 39 will change, i.e. hunt, in accordance with the drift in the plastics pressure (either up or down) automatically subject to the relief valve 37 being set to a pressure value which is greater than the maximum plastics pressure expected. This means that the nitrogen pressure is maintained high enough that it will enter the plastics material and yet not be unnecessarily high, or so high that it would burst the wall or skin of the surrounding plastics material. It is a further advantage that the pressure of the nitrogen in the mass 38 can be increased after the mass is full.

In the above embodiment it is envisaged that the flow of nitrogen through the passageway 19 would be continuous so that a single mass 38 of nitrogen is formed within the plastics material of the required size and at a desired position in the moulding both to exert the intended outward pressure on the plastics material and where a resultant cavity does not adversely affect the finish moulding. However, in another embodiment it may be desired to create two or more separate masses 38 of nitrogen in the moulding. This could be achieved either by arranging for the flow of nitrogen through the passageway 19 to be discontinuous or to provide more than one position in which a passageway 19 enters the moulding space. In the former case, it is preferable to provide dummy passageways 19 so that the pressure from each mass 38 formed can be relieved before the mould is opened. Alternatively, it may be sufficient to allow the pressure of the nitrogen to dissipate itself either by return movement towards its entry point or by effecting movement of the adjacent internal mass of plastics material which is still flowable.

It will also be appreciated that the chosen position for the or each passageway 19 through which nitrogen or other gas is injected into the mould space 12 may be different from the position shown in Figure 1. For example, the selected position may be adjacent the entry point of the plastics material. It may also be desirable that the angle at which the nitrogen is injected is substantially with the flow of plastics material between the mould surfaces rather than transverse to said flow. This could be achieved by the exit port of the passageway 19 being in the side wall of the end of the passageway which protrudes upwardly into the mould space.

Figure 2 is concerned with a similar embodiment to the embodiment of Figure 1, but employs a liquid blowing agent for injection into the plastics material 8 instead of nitrogen. The liquid blowing agent may be any such blowing agent which is commercially available for use in cellular injection moulding, but is preferably one which liberates nitrogen gas at its decomposition temperature. Thereby, as before, the fluid injected effects a weight reduction and an outward pressure on the plastics material urging it towards the mould surfaces. However, there is a different physical result in that the injected fluid does not form at least one mass within the plastics material which results in a cavity or cavities in the finished moulding, but rather decomposes to mix with the central portion of the plastics material to form a porous core 70 in similar fashion to conventional structural foam mouldings. But the present embodiment can provide an important advantage over conventional structural foam mouldings, since if the basic plastics material does not contain a blowing agent, the absence of blowing agent in the outer wall or skin of plastics material during the moulding cycle combined with the effect achieved by pressurising the plastics material against the mould surfaces, means that post-moulding treatment of the external surface of the moulding need not be required.

The mould and screw ram of the moulding press remains substantially unchanged except that in this embodiment the chosen position for introducing the plastics material into the mould space 12 is above the centre of the mould space 12. The position of the injection of the blowing

agent, i.e. the passageway 19, is directly beneath the entry point for the plastics material. In this embodiment the method of injection involves a dual hydraulic ram arrangement which rams are operated in series, the first ram 50 having a cylinder 51, which is the measuring chamber for determining the finite quantity of blowing agent to be injected during a particular moulding cycle, and the second ram 52 effecting the injection. The reason for this dual arrangement is that the blowing agent is pre-heated both whilst it is in the measuring chamber 51 by heater 63 and also by the heater 53 of a further pneumatic ram 54 which has a large capacity cylinder 55 acting as a storage cylinder for the blowing agent fed into the cylinder through conduit 82. The cylinder 55 of the pneumatic ram is connected by a non-return valve 56 to the cylinder 51 of the first hydraulic ram, which is in turn connected to the cylinder 57 of the second hydraulic ram 52 via a solenoid operated valve 58 and a non-return valve 59. The cylinder 57 also has a connection 60 to waste including a non-return valve 61 and a solenoid operated valve 62.

Both hydraulic rams 50, 52 are operated by a common hydraulic pump 71 and electric motor 72, the pump being protected by a relief valve 81, but the rams have their respective two-directional solenoid operated valves 73, 74 and flow control valves 75, 76 each with its bypass 77, 78 including a non-return valve 79, 80.

The operating cycle of this embodiment will now be described. To start with the storage cylinder 55 is filled with liquid blowing agent which is heated by the heater 53. The pneumatic ram is then operated to fill the measuring chamber which is the cylinder 51 of the first hydraulic ram 50. As before the volume of the cylinder may be varied by adjusting the stroke of the ram 50. The metered amount of blowing agent is heated again by heater 63.

The mould is closed and the clamping pressure applied. The feed chamber 15 of the screw ram 13 is full of plastics material. The directional valve 73 of the first hydraulic ram 50 is then energised and solenoid valve 58 opened to allow the ram 50 to transfer the blowing agent from the measuring chamber to the injection chamber which is the cylinder 57 of the second hydraulic ram.

The plastics material is introduced into the mould space 12. When the end of the passageway 19 upstanding in the mould space is immersed in the plastics material the directional valve 74 is energised to cause the second hydraulic ram 52 to inject the blowing agent upwardly into the centre of the plastics material. The contact between the blowing agent and the plastics material further heats the blowing agent to its decomposition temperature. The decomposition of the blowing agent effects a chemical reaction with the plastics material and the generation of nitrogen gas, the combined effect of which is to create a porous core 70 which flows within the surrounding plastics material until the mould space is filled. The effect of the blowing agent is limited by the flow control 76 on the operation of the ram 52 and thereby on the rate of injection of the blowing agent. This is important to ensure that the porous core does not extend to the surface of the plastics material whereby the outer wall or skin is punctured. On the other hand the internal pressure created by the nitrogen causes an outward pressure on the non-porous surrounding plastics material which pressurises it against the mould surfaces. When the introduction of plastics material and the injection of the predetermined, finite quantity of blowing agent is complete, the directional valve 74 is energised to cause the hydraulic ram 52 to withdraw its piston, and the solenoid valve 62 is opened to allow any excess pressure or residue of the blowing agent in the moulding, the passageway 19 and the cylinder 57 to be vented to atmosphere. Normally, sufficient dissipation of this pressure is achieved because the cells of the porous core are generally interconnected back to the point of entry of the blowing agent. However, it is not necessarily essential that the pressure should reduce itself to atmospheric pressure since some degree of internal pressure can be supported by the walls of the moulding. Indeed, in some cases, some of the cells may not be directly interconnected with the entry point but as in the first described embodiment the pressure within those cells can reduce itself to a safe level by effecting movement of the adjacent plastics material which is still flowable. The clamping pressure may then be relieved so that the mould can be opened and the moulding removed.

It will be appreciated that during the above described injection step of the blowing agent, the solenoid valve 58 is closed to allow the measuring chamber to be recharged with the blowing agent from the storage cylinder 55 ready for the next moulding cycle.

If desired the fluid introduced into the plastics material may comprise a mixture of a gas and a liquid blowing agent instead of a gas or a liquid blowing agent only. In this case, Figure 3 shows the storage cylinder 55 of Figure 2 having a gas entry conduit 83 beneath the liquid blowing agent entry conduit 82 and a mixer 84 operated by an electric motor 85. The gas is preferably argon, nitrogen, or freon. The cylinder 55 is filled with both liquid blowing agent and gas which are formed into a homogeneous mixture by the mixture 84 and simultaneously heated by the heater 53. Alternatively, as shown in Figure 4, the storage cylinder 55 may remain unchanged from the embodiment of Figure 2, and the gas introduced into the blowing agent from a supply 86 through a passageway 87 at a position between the non-return valve 56 and the cylinder 51. The passageway 87 has a non-return valve 88 and in this embodiment the gas and liquid blowing agent are mixed by an alternating direction mixer 89 which homogenises the two constituents to produce a mixture which is passed into the cylinder 51. In each case the operating

cycle from thereon is the same as that described with reference to Figure 2.

The gas/liquid mixture may be 1:1 or varied as required to give the desired internal cell structure of the resultant moulding. For example, to produce a more cellular structure, the amount of liquid is increased relative to the amount of gas and vice versa if more open cavities or channels are required. It will thus be appreciated that this gas/liquid variation may be employed to achieve the combination of (a) being able to increase the internal gas-pressure after the introduction of plastics material is complete which is an advantage of the gas only embodiment of Figure 1; and (b) a cellular structure (although not as fine a structure as with liquid blowing agent only) which is desirable to reinforce the outer wall or skin of the moulding.

Figures 5 and 6 relate to a modified embodiment which as shown is applied to the production of a moulding having an internal cavity 38 or cavities, as described with reference to Figure 1, but which is also applicable to the embodiment of Figures 2 to 4 in which the moulding has a porous core or cores resulting from the injection of a blowing agent. The modification concerns the fact that instead of fluid being injected into the stream of plastics material at one or more selected positions within the mould space 12, the fluid is injected upstream of the mould space. The fluid may be injected at any convenient position or positions between the feed chamber 15 of the screw ram 13 and the gate 6 forming the entrance to the mould space 12. In this modified embodiment, the fluid is injected by the ram 39 (or in another embodiment the ram 52) via a passageway 90 having its outlet end at a position which is substantially at the upper end of the space 18 formed during the moulding cycle. For this purpose, the screw 13 has a different nozzle 14 having an end fitting incorporating a spider insert 91 comprising an outer wall 93 joined to a hub 94 by three webs 95, thereby forming three segment-shaped apertures 92 through which the plastics material may flow. The fluid injection passageway 90 passes radially through the outer wall 93 and one of the webs 95 into the hub 94 of the insert. The passageway is then directed axially in the direction of flow of the plastics material to the desired position at which the fluid is to be injected into the plastics material.

In operation, as before, when the flow of plastics material has immersed the outlet end of the passageway 90, the metered quantity of fluid is allowed to pass into the plastics material and flow therewith into the mould space 12 thereby forming the pressurised mass 38 (or porous core 70) which urges the plastics material 8 towards the mould surfaces.

The invention is not restricted to the specific details of the embodiments described above. For example, the basic plastics material may contain a blowing agent mixed therewith within the screw ram.

However, in the case of each embodiment described above it will be appreciated that an injection moulding may be produced which employs less plastics material and is lighter than if the moulding is solid. The creation of the internal pressure also results in a moulding having an external surface which corresponds closely to the internal surface of the mould and which, unlike conventional structural foam mouldings, may be acceptable without post-moulding treatment such as painting. On the other hand, such treatment may still be carried out, if desired. For example, the moulding may be painted to obtain a particular decorative color instead of just to hide blemishes in the external surface. Furthermore, mouldings may be produced in a shorter time than is usual in the case of structural foam mouldings.

CLAIMS

1. A process of producing an injection moulding comprising introducing molten plastics material in the form of a stream into a mould space, and at one or more selected positions injecting a predetermined finite quantity of fluid under pressure into the stream of plastics material at a controlled rate, the fluid flowing with the plastics material between the mould surfaces to fill the mould space and exerting an outward pressure on the surrounding plastics material to pressurise the plastics material towards the mould surfaces.

2. A process as claimed in Claim 1, including measuring the predetermined quantity of fluid in a chamber prior to the injection of the fluid into the plastics material.

3. A process as claimed in Claim 1 or Claim 2, wherein the pressure of the fluid injected fluctuates with the pressure of the plastics material, whilst remaining higher than that pressure to ensure a uniform injection of the fluid throughout the moulding cycle.

4. A process as claimed in any one of the preceding claims, wherein some or all of the fluid is injected into the plastics material at one or more selected positions within the mould space.

5. A process as claimed in any one of the preceding claims, wherein some or all of the fluid is injected into the plastics material at one or more selected positions upstream of the mould space.

6. A process as claimed in any one of the preceding claims, wherein the fluid is a gas, preferably nitrogen or other inert gas.

7. A process as claimed in any one of the preceding claims, wherein during the flow of the fluid with the plastics material, the fluid forms at least one mass within the plastics material which exerts said pressure on the plastics material towards the mould surfaces, and including the steps of maintaining the pressure until the plastics material is self-supporting, and then relieving the pressure or allowing the pressure to dissipate itself to an acceptable level before the mould is opened.

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The gas/liquid mixture may be 1:1 or varied as required to give the desired internal cell structure of the resultant moulding. For example, to produce a more cellular structure, the amount of liquid is increased relative to the amount of gas and vice versa if more open cavities or channels are required. It will thus be appreciated that this gas/liquid variation may be employed to achieve the combination of (a) being able to increase the internal gas-pressure after the introduction of plastics material is complete which is an advantage of the gas only embodiment of Figure 1; and (b) a cellular structure (although not as fine a structure as with liquid blowing agent only) which is desirable to reinforce the outer wall or skin of the moulding.

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2. A process as claimed in Claim 1, including measuring the predetermined quantity of fluid in a chamber prior to the injection of the fluid into the plastics material.

3. A process as claimed in Claim 1 or Claim 2, wherein the pressure of the fluid injected fluctuates with the pressure of the plastics material, whilst remaining higher than that pressure to ensure a uniform injection of the fluid throughout the moulding cycle.

4. A process as claimed in any one of the preceding claims, wherein some or all of the fluid is injected into the plastics material at one or more selected positions within the mould space.

5. A process as claimed in any one of the preceding claims, wherein some or all of the fluid is injected into the plastics material at one or more selected positions upstream of the mould space.

6. A process as claimed in any one of the preceding claims, wherein the fluid is a gas, preferably nitrogen or other inert gas.

7. A process as claimed in any one of the preceding claims, wherein during the flow of the fluid with the plastics material, the fluid forms at least one mass within the plastics material which exerts said pressure on the plastics material towards the mould surfaces, and including the steps of maintaining the pressure until the plastics material is self-supporting, and then relieving the pressure or allowing the pressure to dissipate itself to an acceptable level before the mould is opened.

14. Apparatus for producing an injection moulding of plastics material comprising means for introducing the plastics material in the form of a molten stream into a mould space, and separate means around which flows the stream of plastics material for injecting a non-plastics fluid under pressure directly into the plastics material at one or more selected positions, the fluid thereafter flowing simultaneously with the plastics material between the mould surfaces to fill the mould space, wherein the means for injecting the fluid are adapted to inject a predetermined, finite quantity of the fluid, and means are provided for controlling the rate of injection of the fluid to enable the fluid to exert a pneumatic pressure on the surrounding plastics material to pressurise the plastics material outwardly towards the mould surfaces.

15. Apparatus as claimed in Claim 14, wherein the means for injecting the fluid include means for measuring the finite quantity of fluid to be injected.

16. Apparatus as claimed in Claim 15, wherein for the or each selected position the fluid injection means is a piston and cylinder arrangement, the cylinder being connected by a passageway projecting into the path of the plastics material.

17. Apparatus as claimed in Claim 16, wherein the cylinder of the fluid injection means comprises a measuring chamber for the fluid.

18. Apparatus as claimed in Claim 16, wherein for the or each selected position the fluid injection means includes a second piston and cylinder arrangement connected in series and upstream of the first-mentioned piston and cylinder arrangement, the cylinder of the second piston and cylinder arrangement comprising a measuring chamber for the fluid.

19. Apparatus as claimed in any one of Claims 15 to 18, wherein the effective volume of said measuring means is adjustable to allow the finite quantity of the fluid to be varied.

20. Apparatus as claimed in any one of Claims 15 to 18, wherein said measuring means has means for heating the fluid therein.

21. An injection moulding formed by a process as claimed in any one of Claims 1 to 13, or apparatus as claimed in any one of Claims 14 to 20.

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